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MINING AND GRINDING METHODS AND COSTS AT THE EVANS PIPE CO. CLAY MINE, UHRICHSVILLE, OHIO

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MINING AND GRINDING METHODS AND COSTS AT THE EVANS PIPE CO. CLAY MINE, UHRICHSVILLE, OHIO[1]

By E. J. Lintner[2]

INTRODUCTION AND ACKNOWLEDGMENTS

This paper is one of a series being prepared by the United States Bureau of Mines describing clay mining, crushing and grinding methods, and costs, at various operations throughout the United States. These papers are designed to disseminate technical information regarding methods used. The cost tabulations represent local operating expenditures only and not total production costs. It is recognized that publication of total production costs may in many instances cause embarrassment to the individual operator as well as to the industry as a whole. On the other hand, operating costs are essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulation shall ensue.

The following report deals specifically with the methods employed by the Evans Pipe Co., Uhrichsville, Tuscarawas County, Ohio. The author wishes to acknowledge the assistance of the following company officials: T. J. Evans, II, president; T. J. Evans III, vice president and general manager; and L. P. Young, general superintendent.

BRIEF HISTORY AND EARLY DEVELOPMENT OF DISTRICT

The exact date of the founding of the ceramic industry in Tuscarawas County is not definitely known. Our earliest report is that in 1827 roofing tile was made by a colony of "Zoarites" at Zoar, in Lawrence Township for their own use. There was no commercial manufacture of roofing tile in Ohio until 1873 at Zanesville. The Bureau of the Census lists two pottery plants as operating in the county in 1840. Only four men were employed at these plants, and the products were evidently marketed locally.[3]

Although the sewer-pipe industry in Ohio began in 1849 in the vicinity of Akron, it was not until 1887 that the first plant started operating in the Tuscarawas Valley. Expansion was rapid, and within a short time this county became

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6929".

[2] Associate mining engineer, U. S. Bureau of Mines.

[3] Stout, Wilbur; Stull, R. T., McCaughey, Wm. J., and Demorest, D. J., Coal Formation Clays of Ohio: Geological Survey of Ohio Bull. 26, 1923, pp. 14-15

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the largest producer of ceramic products in the State. The rapid growth of the industry is shown as follows:

Year	Number of operating plants
1887	1
1900	4
1923	13
1928	41

The industry is located in the Tuscarawas River Valley and its tributaries but centers around Uhrichsville (fig. 1). Sewer pipe is manufactured in fully 40 percent of the plants while face brick and hollow tile and fire brick are made in the balance. The wares from this district are of a very high quality. They are shipped to distant markets, consumers preferring them to those obtainable from local sources. It is interesting to note that what is claimed to be the largest sewer-pipe plant in the United States is located in this valley.

The Evans Pipe Co. was organized in 1907 by T. J. Evans I. A site was selected south of Uhrichsville, in the valley of the Big Stillwater Creek. Both the clay and coal seams were opened and a large plant was erected to manufactu sewer pipe. The coal supply has since been exhausted. The clay mine now bein worked was opened in 1913. The plant is served by a branch line of the Baltimore & Ohio Railroad Co.

GEOLOGY

The clay mined is the Lower Kittanning member of the Allegheny formation, belonging to the Pennsylvanian system. The Allegheny is the important clay-bearing formation of Ohio, having in all eight important clay members. Its thickness ranges from 175 to 250 feet but averages about 200 feet.4/ The Lowe Kittanning is by far the most important member and is widely and uniformly di tributed over a very large area.

This member is composed of a bed of coal overlying a bed of very good qu ity clay. Its thickness ranged from 2 to 20 feet, averaging, in Tuscarawas County, 2 1/2 feet for the coal and 10 feet for the clay.5/ Its value is bes expressed by Dr. Edward Orton, who stated, "It is probably equal in value to other sources of clay in the Coal Measures combined".6/

This bed of clay really represents7/:

Two distinct periods of clay formation, one preceding the deposition of the thin bed of Lawrence coal about midway in this interval, and the other preceding that of true Lower Kittanning coal. The interruption, however, was short but so modified that coal was preserved in local areas and flint

4/ Same as footnote 3, p. 243.
5/ Same as footnote 3, p. 305.
6/ Orton, Edward, Geological Survey of Ohio, vol. 7, 1833, p. 65.
7/ Same as footnote 3, p. 272.

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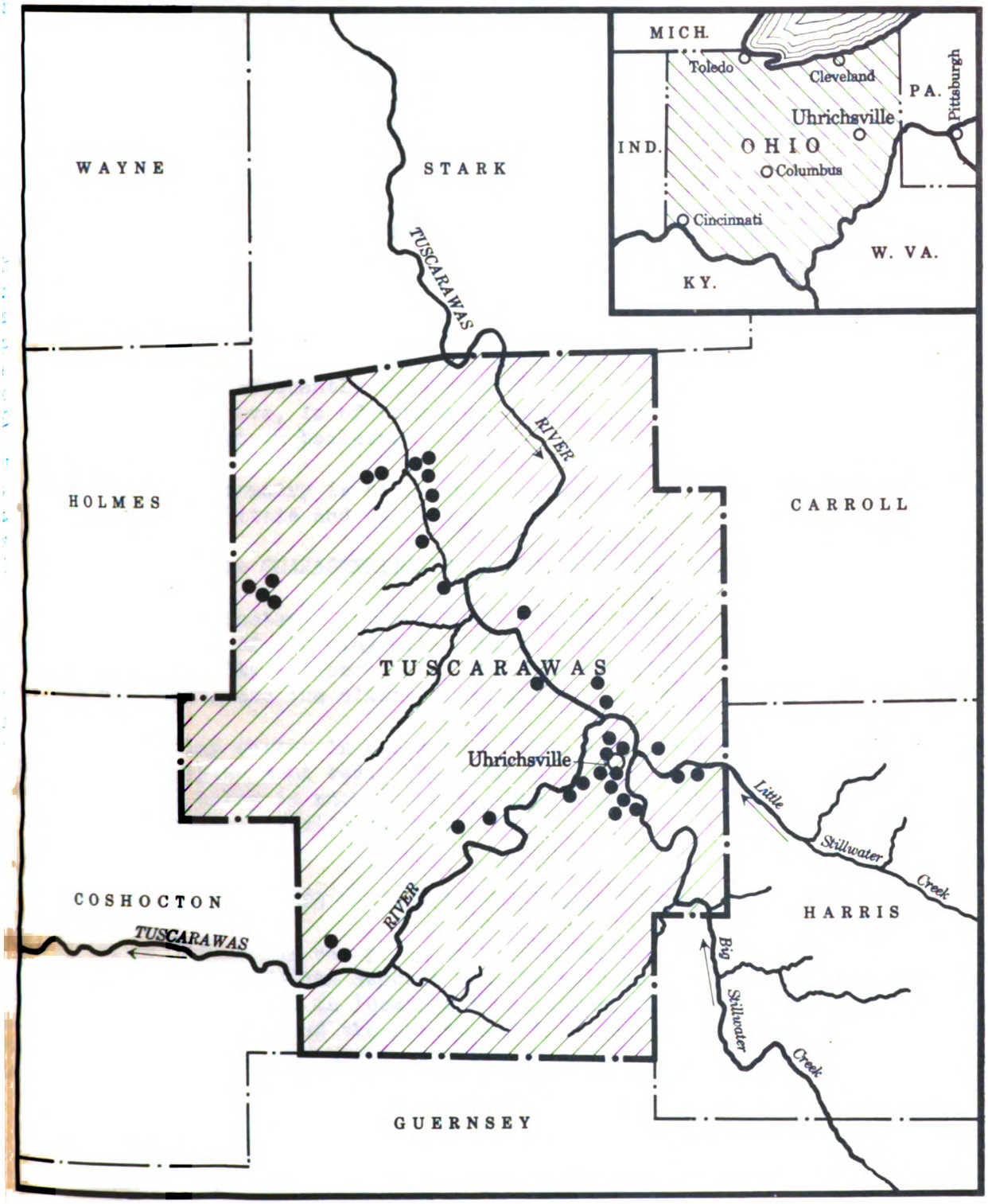

Figure 1.—Location of ceramic plants, Tuscarawas County.

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clay to some extent was laid down over a wide field. In places also it permitted deposition of a few feet of intervening shale and sandstone. On this interpretation the flint or flinty clay about midway in the deposits and the plastic clay below this belong to the Lawrence coal or to its formation period and not to the Lower Kittanning coal. Only the overlying coal should be attributed to the latter. As one bed is superimposed on the other over such wide areas and as they are mined together in so many places they need not be treated separately for economic purposes.

It appears that in this region conditions were especially favorable for the ormation of a flint clay and not for the deposition of the lower bed of coal, hence ts absence.

In addition to the various clay members, the Allegheny is also the chief coal-earing formation of Ohio; thus the necessary fuel for the manufacturing of clay roducts is close at hand. The Lower Kittanning coal directly above this clay is f poor quality and consequently is not used. The Middle Kittanning or No. 6 coal, ying 30 to 40 feet above, is of very good quality and is used both in the kilns s well as under the steam boilers.

The surrounding country is hilly and is traversed by the Tuscarawas River and ts tributaries, the Little and the Big Stillwater Creeks.

PHYSICAL CHARACTERISTICS OF CLAY AND ENCLOSING ROCKS

In almost every instance the Lower Kittanning clay is found above drainage evel. The thickness of the clay will average 7 1/2 feet. Beneath the clay being ined is a bed of highly siliceous clay entirely unsuited for manufacturing purposes. In most instances the electric drill used in the mine will not penetrate it.

The plastic clay varies in color from light gray below to dark gray above approaching the overlying coal bed. The texture of this clay is very fine. That of he siliceous clay below is much coarser. The plastic clay has a high bonding ower and disintegrates readily on weathering.

METHODS OF PROSPECTING AND EXPLORATION

A series of test holes was put down with a churn drill at irregular intervals to determine the extent of the deposit and the tonnage available. No definite or ystematic spacing was used in locating these holes. This drilling proved doubly aluable, since it determined the extent and thickness of the No. 6 coal bed, as ell as the thickness of the strata between this coal and the Lower Kittanning lay.

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The log of a typical borehole is as follows:

	Feet	Inches	
Surface clay	6	0	
Shale and clay	42	0	
Shale	6	0	
Soft coal no. 7	0	6	
Fire clay (good)	6	0	
Sandy clay	5	0	
White rock	34	0	
Sand rock	13	0	
White rock	12	0	
Shale	11	0	
Coal, Blossom no. 6A	0	3	
Fire clay	5	0	
Yellow sandstone	50	0	
White sandstone	15	0	
Shale	8	0	
Sand rock	5	0	
Shale	12	0	
Coal no. 6	3	9	(mined out
Fire clay no. 6	21	6	
Sand rock	1	0	
Shale	10	0	
Coal no. 5	4	8	(mine roo
Clay no. 5	8	0	(present

METHODS OF SAMPLING AND ESTIMATION OF TONNAGE AND VALUES

The clay mined is very uniform, and it is only necessary to take occasi mine samples to maintain proper control over the quality of the finished pro

Typical analyses of samples of a mine face cut from top to bottom in a channel 4 inches wide and 2 inches deep are given below:

	Samples		
	A	B	C
Silica, SiO_2	66.55	65.10	70.00
Alumina, Al_2O_3	27.40	28.35	23.75
Ferric oxide, Fe_2O_3	1.91	2.00	1.54
Titanic oxide, TiO_2	2.17	2.21	1.70
Lime, CaO	.40	.38	.27
Magnesia, MgO	.15	.43	.49
Alkalies	1.36	1.47	2.06
Soluble sulphates	.09	.06	.09
Gloss factor:			
Cone 3	.1126	.1270	.041
Cone 4	.1431	.1605	.065

Sample A was taken near top of bed
Sample B was taken near center of bed
Sample C was taken near bottom of bed

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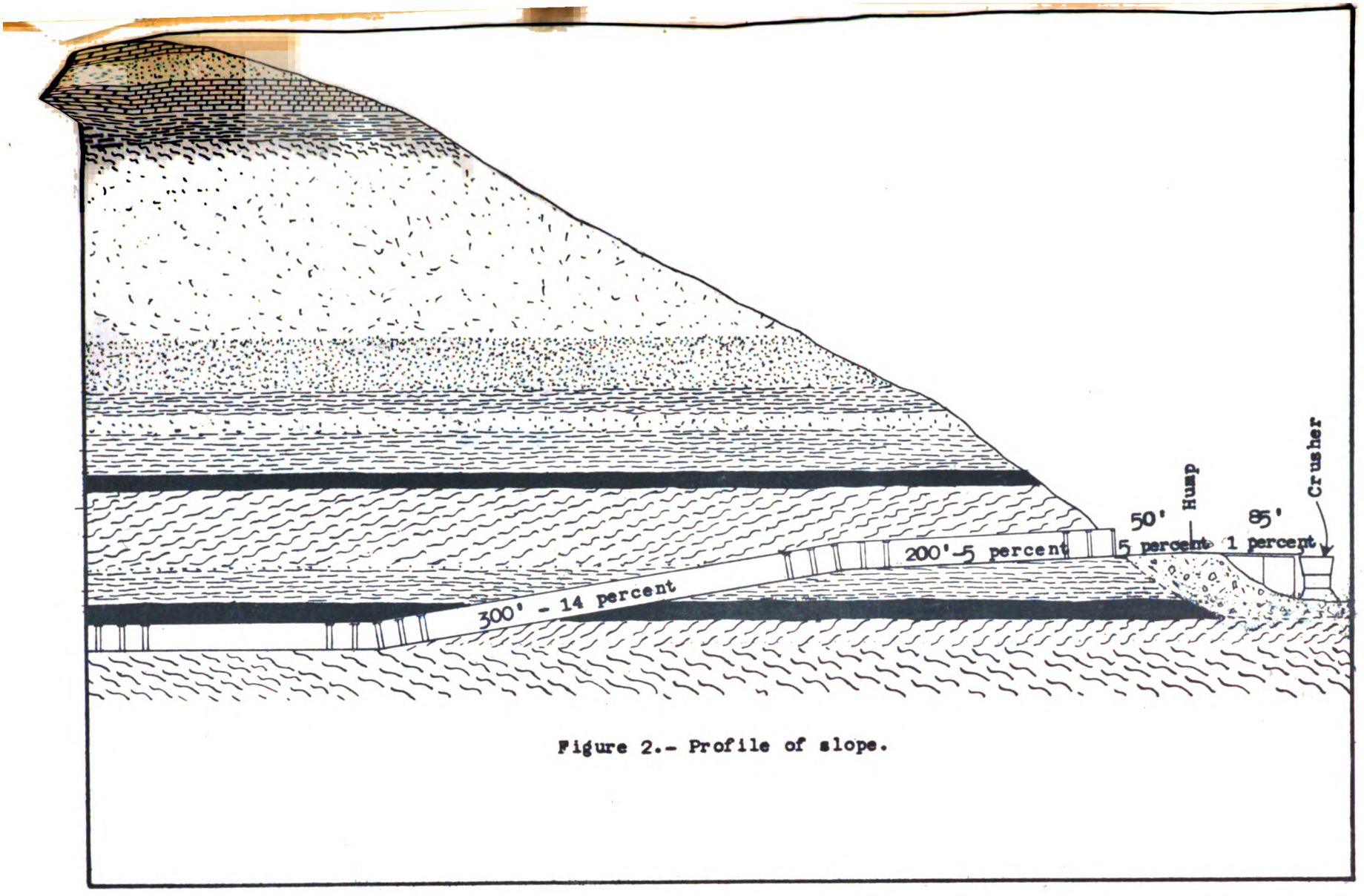

Figure 2.- Profile of slope.

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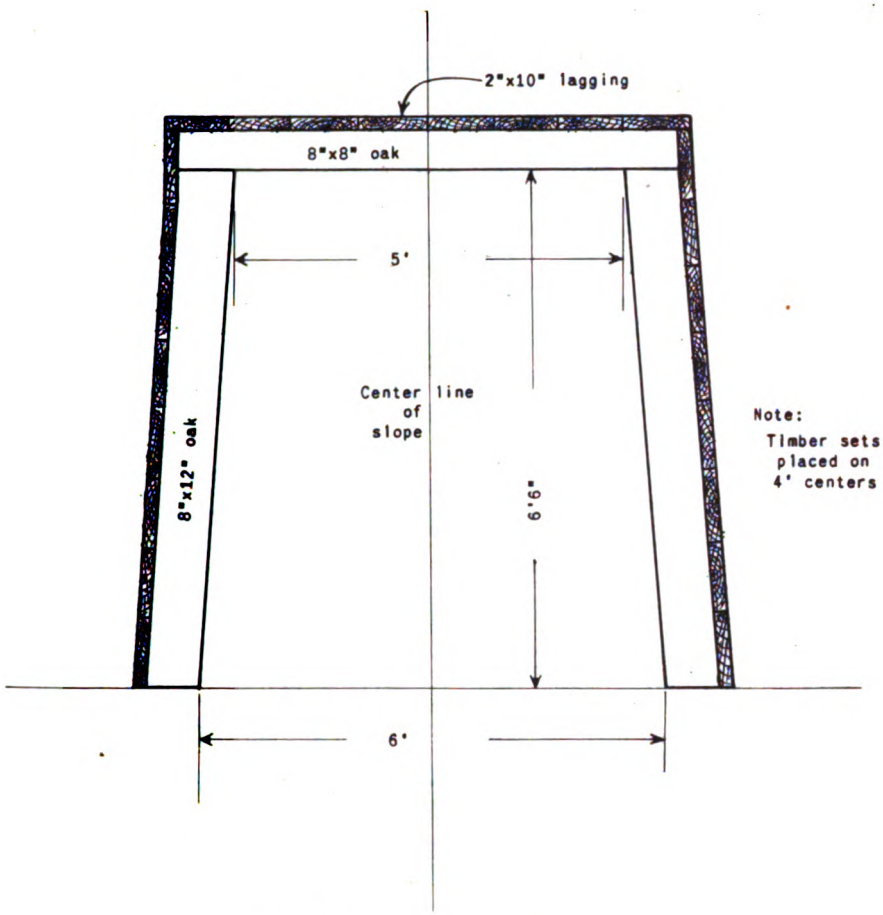
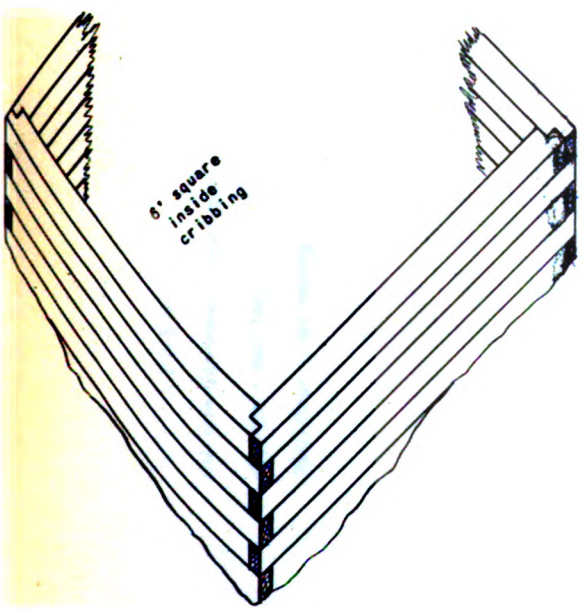
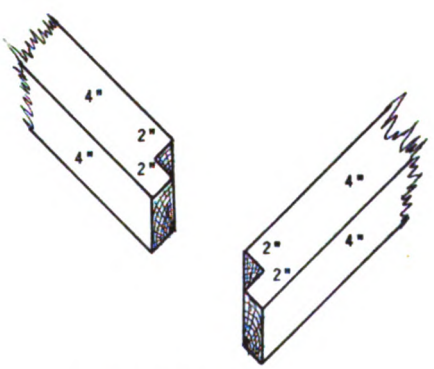


Figure 3(a).- Slope timber sets.





Detail of framing

Figure 3(b).- Air-shaft cribbing.

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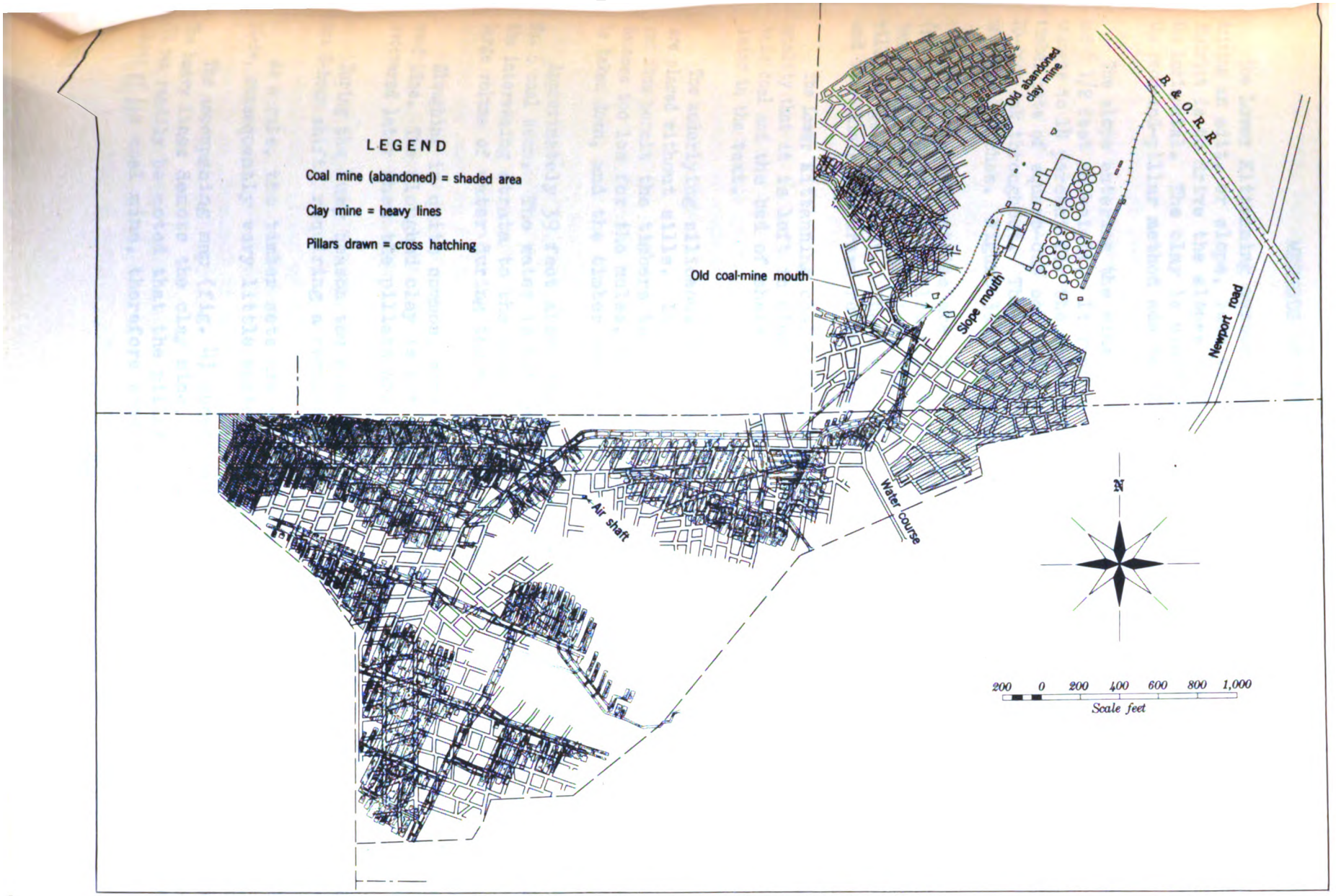

Figure 4.—Map of property and mines, Evans Pipe Co., Tuscarawas County, Ohio.

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METHODS OF DEVELOPMENT AND MINING

The Lower Kittanning member is above drainage and is easily reached by driving an adit, or slope, into the hillside. The prevailing practice in this district is to drive the slopes on 10- to 25-percent grades or 6 to 14° below the horizontal. The clay is mined by using a single- or double-entry system of the room-and-pillar method adapted from coal mining.

The slope entering the mine of the Evans Pipe Co. measures 6 feet in width and 6 1/2 feet in height. It runs down grade at 5 percent for 200 feet, then changes to 14 percent for the remaining depth (fig. 2). Three-piece untreated timber sets of square-cut oak are placed on 4-foot centers and lagged with 2- by 10-inch oak throughout. The posts measure 8 by 12 inches while cap pieces measure 8 by 8 inches. Figure 3a shows these timber sets in detail.

The rooms and entries are usually driven 12 feet wide on 100-foot centers (fig. 4). Crosscuts are also placed on 100-foot centers, so that pillars approximately 88 feet square are left for support. The height of the rooms and entries will average 7 1/2 feet. The rooms and entries are driven to the property lines, and the pillars are drawn retreating.

The Lower Kittanning coal member directly over the clay bed is of such poor quality that it is left in place. It requires considerable timbering to hold this coal and the bed of shale over it. The method of timbering is discussed later in the text.

The underlying siliceous clay forms a hard, firm floor on which timber sets are placed without sills. In some unusually wet places the floor will soften and thus permit the timbers to settle and cause a squeeze. When the headroom becomes too low for the mules, the cap pieces are removed, a portion of the coal is taken down, and the timber sets are replaced.

Approximately 39 feet above the clay mine is the abandoned coal mine in the No. 6 coal seam. The water is not removed from this old mine but seeps through the intervening strata to the clay mine below, necessitating the handling of a large volume of water during the wet season and causing wet mining conditions.

Sloughing is quite common, some places now being 18 to 20 feet wide at the roof line. The sloughed clay is not removed at present but will, no doubt, be recovered later when the pillars are drawn.

During the busy season the mine produces approximately 200 tons of clay in one 8-hour shift, requiring a regular crew of approximately 20 men underground.

As a rule, the timber sets are sufficient to hold the overlying coal bed in place, consequently very little waste material is handled.

The accompaning map (fig. 4) shows the plant layout and the mine workings. The heavy lines denote the clay mine, the lighter ones the abandoned coal mine. It can readily be noted that the pillars of the clay mine are not directly under those of the coal mine, therefore some trouble from caving is experienced from

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the weight on these coal-mine pillars where they are located over the open rooms and entries of the clay mine.

MINING

Drilling

All drilling is done by one man with a 3-horsepower, 250-volt, direct-current, electric rotary drill, using twisted steel having a fishtail or "Y" bit. The solid feed bar on the drill is 1 1/2 inches in diameter and 5 feet long. It has six threads per inch. This bar passes through the center of a hollow armature. The feed nut is contained in a casing or hub held by friction The hub is caused to revolve when excessively hard material is encountered, an instantly the forward movement of the auger is stopped, but its rotation continues. By varying the friction of the feed-nut casing the forward movement of the feed bar is controlled at will. The feed screw revolves at 106 revolutions per minute (fig. 5a).

The drill steel used is 2 inches in diameter and has 5 1/2 turns per foo It is made up in sets of three pieces, of 3-, 5-, and 8-foot lengths, with cor responding fishtail bits measuring 2 3/4, 2 1/2, and 2 1/4 inches gage.

The drill is mounted in a double column, being suspended from the top cr member by a wire rope, and provided with a hand winch for raising and loweri the motor to the desired height for drilling. A flexible, duplex, rubber-insulated cable 250 feet in length, wound on a reel 10 inches in diameter by 18 inches in length, carries the electric power. Direct current is used.

The drilling outfit is moved from place to place on a small, light flat car. The car, with the column lying lengthwise on it, is pushed to the end o the track. The column, with the drill already mounted, is slid off the end o the car and lifted into position in the center of the room approximately 6 fe from the face. After the column is tightened by means of the hand wheel and screw on the bottom yoke and the electric connections are made from the reel to the drill by placing the insulated plugs over the terminals on the drill, the drilling is ready to start. A small hole is now made with a pick in the face at the desired point where the hole is to be drilled so that the bit wi readily take hold. With a 3-foot steel in the chuck, the feed bar is advanc until the bit contacts the face, the feed box is closed and clamped, the ele tric connections are made, and the actual drilling commences.

When the 3-foot length of steel has advanced its full length, it is rem by opening the boxing, thus releasing the feed bar, so that it can be drawn out of the way. The steel is removed from the hole by hand. Sometimes an e tension steel bar fitted with male and female ends is used between the feed and the drill steel. This is 3/4 inch in diameter and 2 feet in length. In this manner, a hole can be drilled a little deeper if desired, or the requir depth can be drilled should the column have been set too far from the face.

The top holes are drilled at such an angle that they end about 6 inches the roof. Nine holes are drilled in each face, all being drilled from the c position of the column in the center of the room. Figure 5 shows the drill

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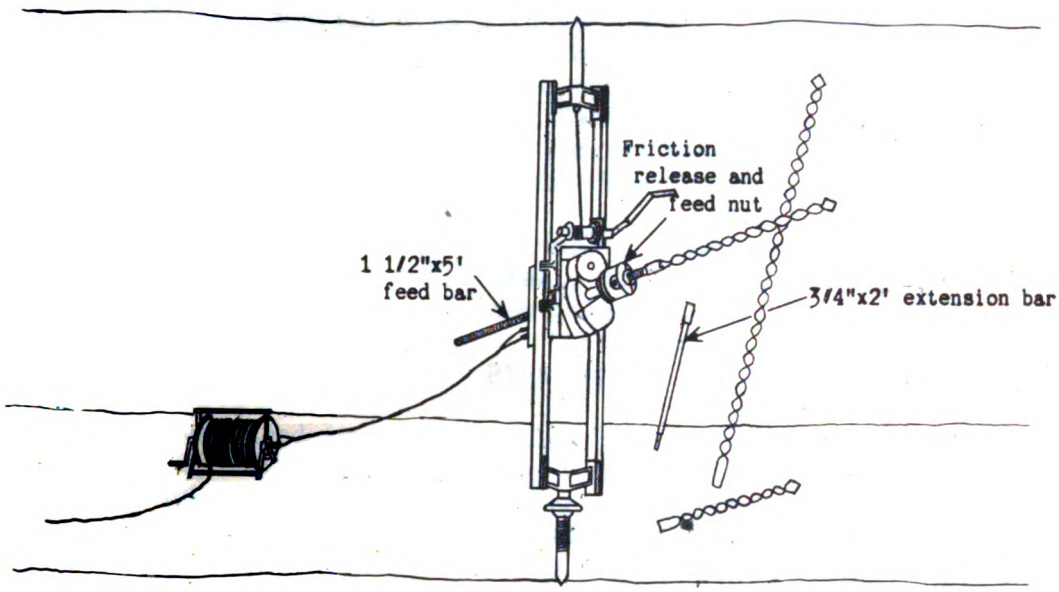

Figure 5(a).- Electric drill.

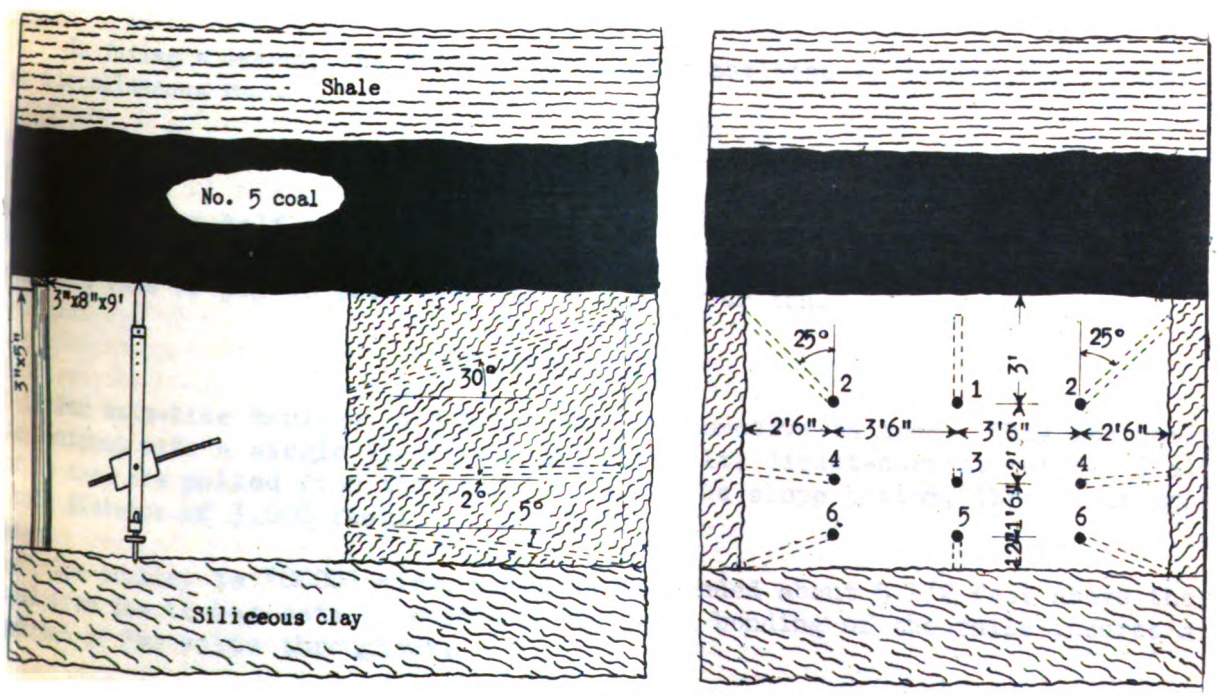

Figure 5(b).- Drill round.

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The holes are usually drilled to a depth of 8 feet. It requires 5 minutes actual drilling time to drill a hole to this depth, or approximately 45 minutes for each face. This is at the rate of about 19 inches per minute, requiring approximately 0.023 Kw.-hr. of electric energy per foot. In a working day of 8 hours, one operator will drill three faces or rooms. The balance of his time is spent in moving from place to place, cleaning out the holes, making up his tamping and explosive cartridges, cutting the fuse and loading the holes.

When the face is drilled, the column is released from its position and returned to the flat car. The drill steel, tools, reel, etc., are loaded, and the outfit is ready to be moved to its new location.

Blasting

The explosives used are No. 4 pellet powder, size 1 3/4 inches by 8 inches, and Gelax No. 2 dynamite, size 1 1/4 by 8 inches. Four sticks of the former are placed in each of the three top holes, and five sticks of the latter are placed in the six remaining holes. No. 6 blasting caps are inserted in the last stick. The balance of the hole to the collar is filled with tamping. Tamping shells 2 1/2 by 14 inches are rolled from waxed paper and filled at the face from the drill-hole cuttings. Eight-foot double-tape safety fuse is used. The order of firing is indicated in figure 5 by the small numbers.

Each face of nine holes will produce approximately 30 cars or 45 tons, the equivalent of 2.2 tons of clay per pound of explosive used.

In firing a round, the driller is usually assisted by either the trackman or miscellaneous man.

Loading

One and one-half ton cars are hand loaded by nine men regularly employed at this work. Each man works alone and averages 14 cars or 21 tons per day. The contract rate of pay is $0.39 per car or $0.26 per ton.

Transportation

For main-line haulage, a 5-ton trolley locomotive is used. This locomotive is equipped with a single 35-horsepower, 250-volt, direct-current motor. Trains of 15 cars are pulled from the main siding to the slope bottom, through an approximate distance of 3,600 feet.

The trolley is "0000" wire, which is suspended about 5 1/2 feet above the rail from the timber sets by wooden arms. Good bonding of the rails insures a current of 240 volts throughout.

Two mules are required to distribute the cars from the main siding to the various working faces near by.

Tracks are of 36-inch gage. Forty-pound rails are used in the main haulage entry and slope, while 25-pound rails are used in the other entries and on room

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curves. Room frogs are size No. 2. The balance of the room track is made of 3-inch by 5-inch by 8-foot oak timbers lying flat. When these timbers are worn to such an extent that they cannot be used further as rails, they are cut in two and used as room ties.

The mine cars (fig. 6) are solid wooden body construction, made by the mine repair man. These are of 28 1/2-cubic foot capacity and weigh 1,350 pounds. An average net load of approximately 3,000 pounds is carried. There are 55 cars in daily use, with 10 held in reserve and undergoing repairs.

A single link, 16 by 4 1/2 inches, made of 1-inch-diameter steel, is used for the coupling. Coupling pins 1-1/8 inches in diameter and 7 inches in length are fastened to the end of the car by a small chain.

Timbering

Considerable timbering is required; three-piece timber sets are placed 6 feet apart down the center of each room and entry, and they are carried to within 8 to 10 feet of the working face. The timber is cut locally and measures 8 inches in diameter at the small end. Untreated oak, chestnut, maple, and hickory are used. The posts are set 6 feet apart at the top and 8 feet apart at the floor. They are capped with a 3-inch by 8-inch by 9-foot oak plank and securely wedged into place. A 3- by 5-inch collar brace is usually placed between each set at the roof line along each line of posts, and the whole spiked together. This work requires two men constantly at the face (fig. 7).

Last year, a large number of timber sets were replaced along the main haulage entries. These sets are placed midway between the old existing sets. This work is very slow and expensive. Solid bottom must be reached, and if the track has been raised or if there is standing water, post holes 1 to 3 feet deep in wet, sticky clay are required. The life of these timbers is 8 to 10 years.

Pumping

Considerable water is encountered, most of which comes from the abandoned coal mine above. This water is highly acid and corrosive and consequently must be handled with special equipment. A 6- by 8-inch duplex wood-lined pump having a 4-inch suction is used as a gathering pump in the working places. This is gear driven by a 5-horsepower, 250-volt, direct-current motor rotating at 1,150 r.p.m. Its capacity is 40 gallons per minute, and it discharges into the main sump. Water from other workings is ditched into this same sump. A single-stage 3-inch, side-suction, centrifugal pump whose body, shaft, and impeller are made of an acid-resisting alloy takes the water from this sump and pumps it over a slight raise a distance of approximately 2,300 feet, where it then runs by gravity through a second opening on the opposite side of the hill from the main entrance. Its rated capacity is 225 gallons per minute, and it is driven by a 15-horsepower, 250-volt, direct-current motor at 1,150 r.p.m. Six-inch, machine-banded, wooden pipe is used on both pumps. Cast-iron pipe formerly used on the gathering pump lasted only 3 months. In 1935, a rather wet year, approximately 2,000 gallons of water were pumped per ton of clay mined.

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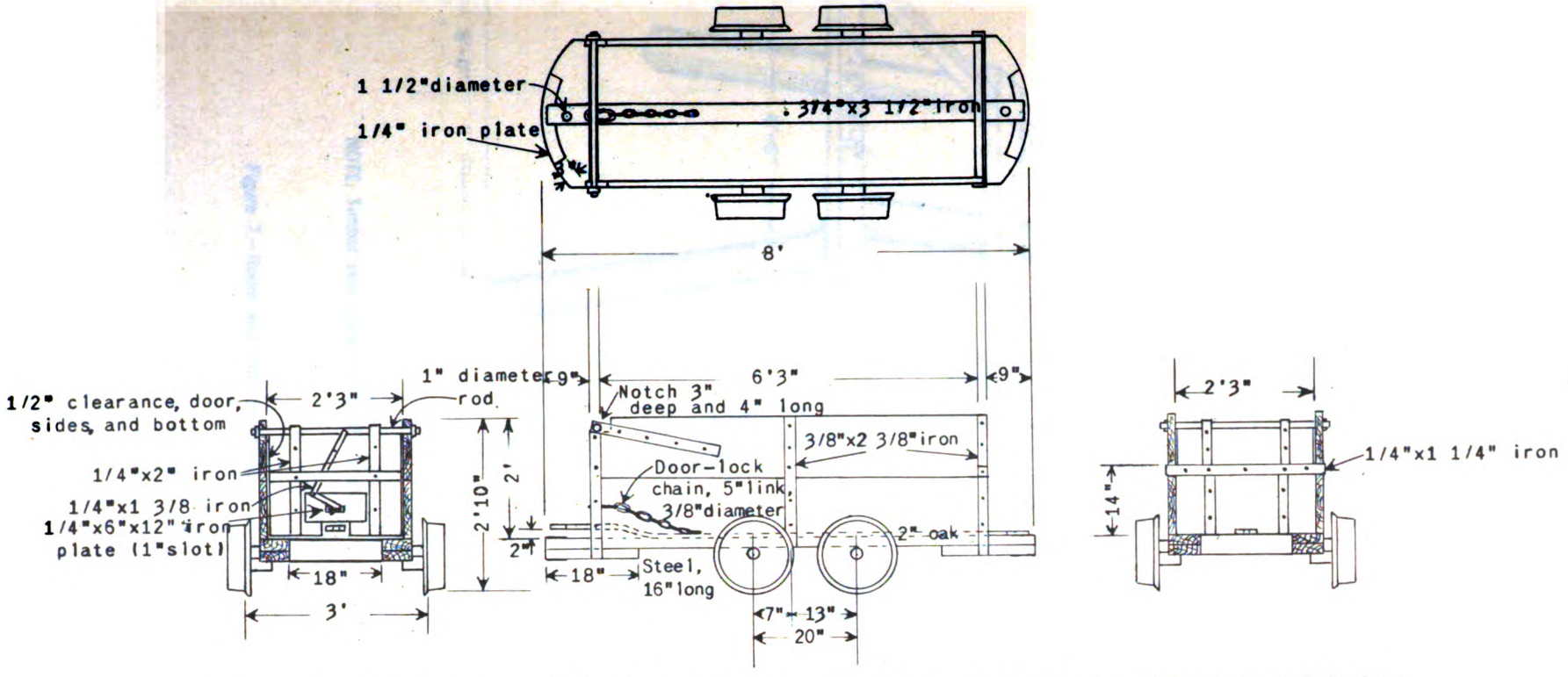

Figure 6.- Mine car. Wheel diameter, 14 inches; wheel face, 3 1/2 inches; wheel base, 20 inches; axle diameter, 1 1/2 inches; axle length, 46 inches; sides and ends, 1 1/4-inch oak; bottom, 2-inch oak; coupling link, 1-inch diameter steel, 4 1/2 by 16 inches; coupling pin,1 1/8-inch diameter steel, 7 inches long; capacity, 28 1/2 cubic feet.

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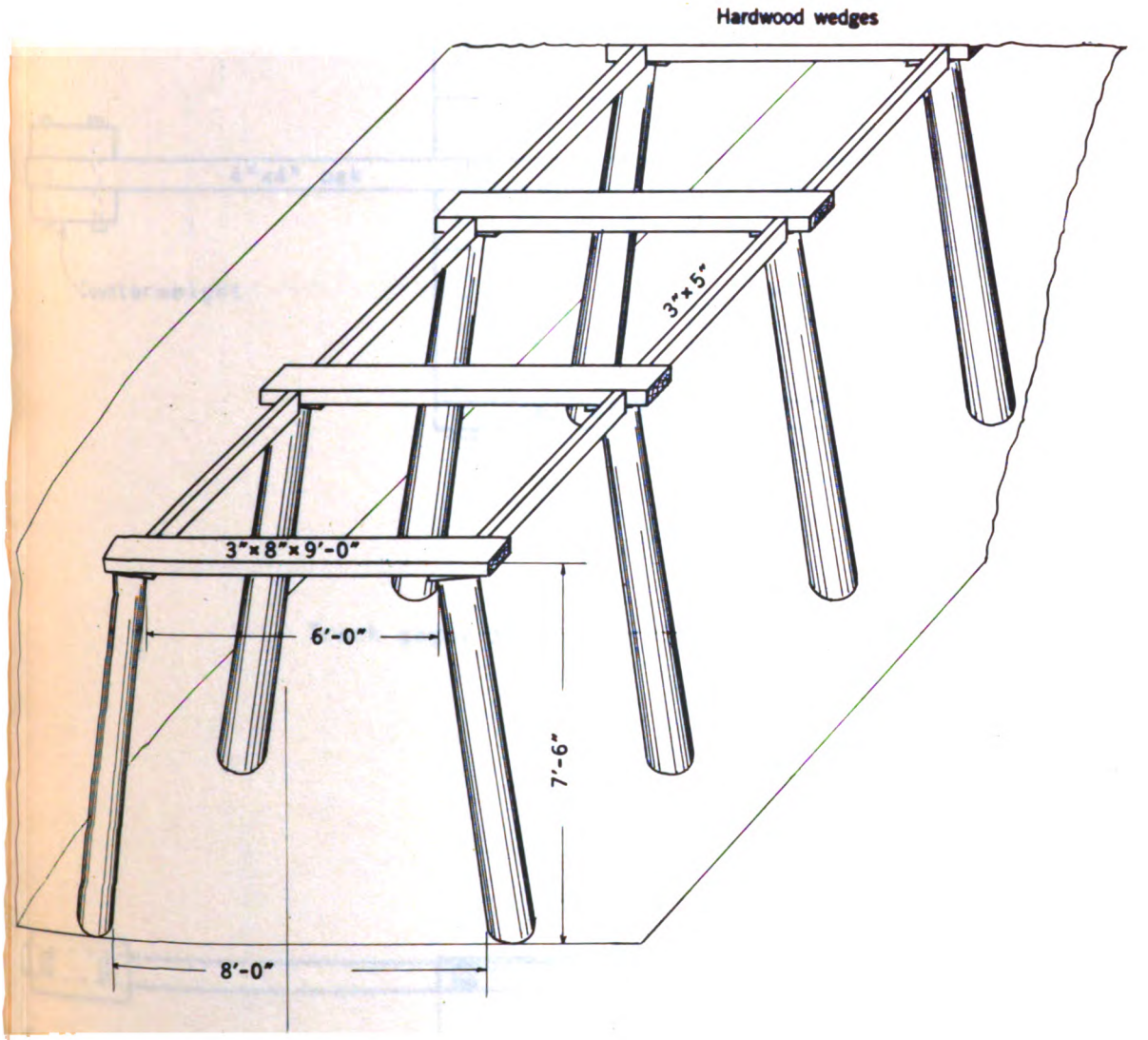

NOTE: Timber sets placed on 6'-0" centers

Figure 7.– Room and entry timbering.

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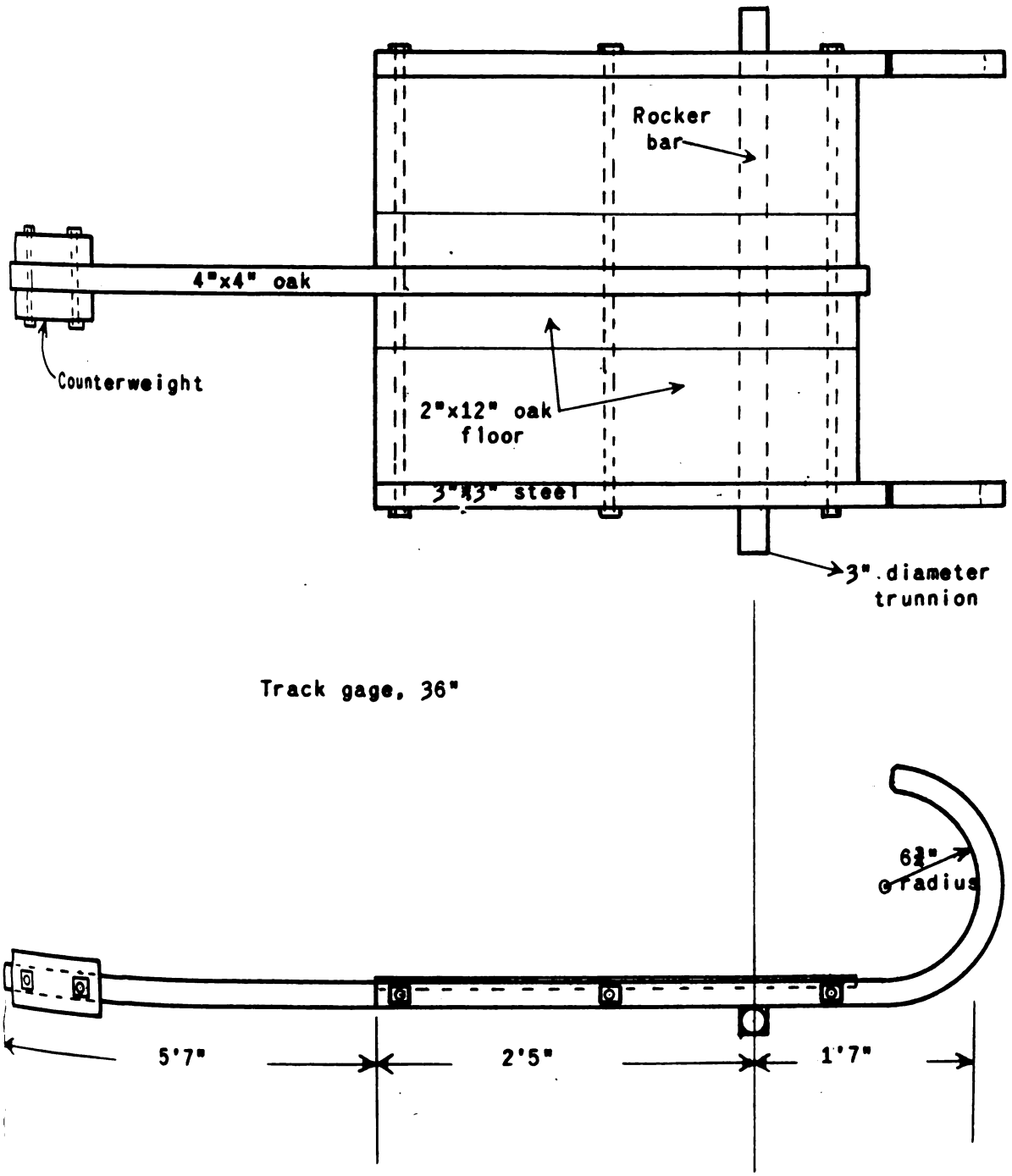

Figure 8.—Kick-back dump.

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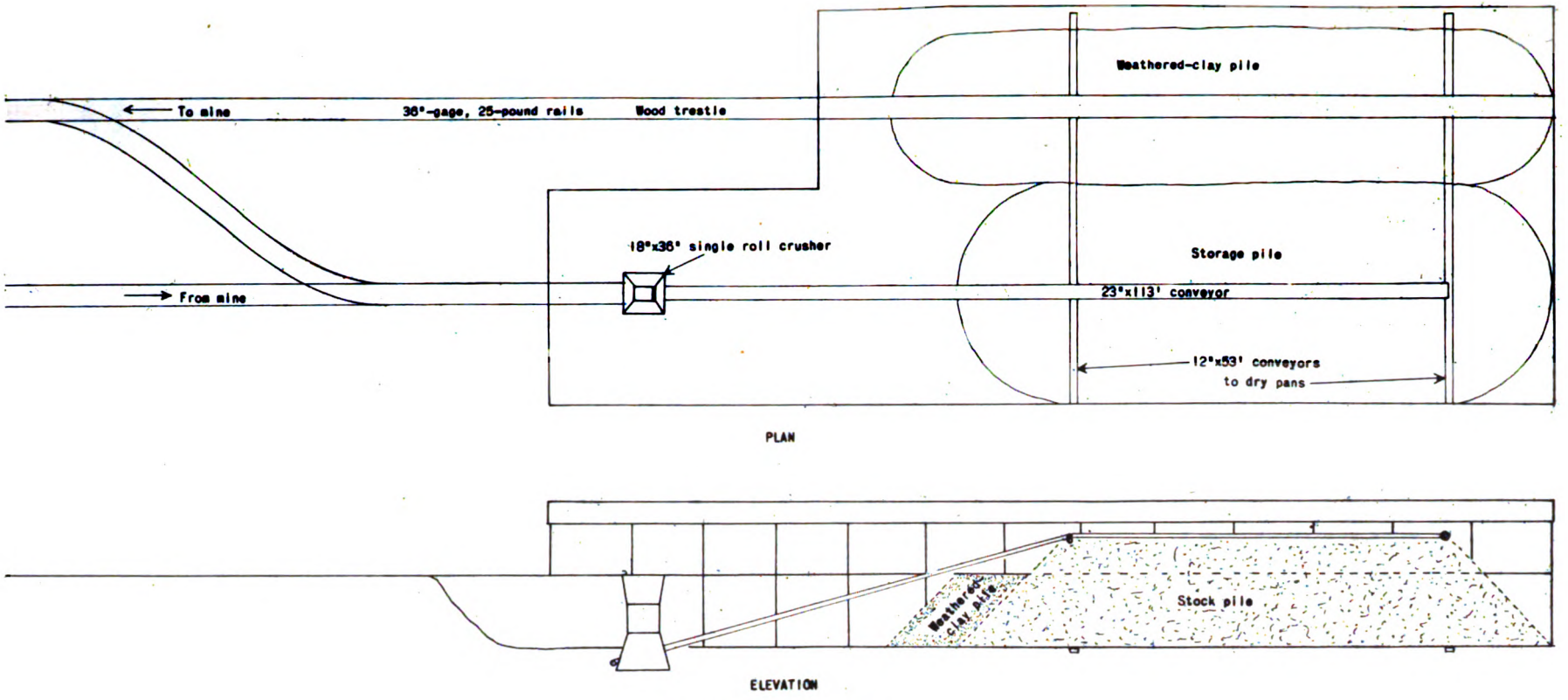

Figure 9.- Storage arrangement.

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Ventilation

Excellent ventilation is obtained by natural means. The slope serves as the intake, and the air is exhausted through an air shaft the collar of which is approximately 60 feet above the clay bed (fig. 4). A small, portable, booster fan is employed quite frequently inside. This is an eight-blade, 36-inch-diameter disk fan driven at 300 r.p.m. by a 5-horsepower, 250-volt, direct-current motor, having a speed of 1,150 r.p.m. The fan delivers 6,250 cubic feet of air per minute.

The air shaft measures 6 by 6 feet inside the cribbing and was sunk from the surface. It is close cribbed throughout by 4 by 4 inch oak. Figure 3b shows the method of timbering.

Hoisting

A single, cone-friction drum, electric-geared hoist is used to pull a trip of five cars from the slope bottom. The drum, whose diameter is 24 inches and whose face is 24 inches, has a speed of 36 r.p.m. The average hoisting speed is 226 feet per minute. A 6 by 19, 5/8-inch-diameter plow-steel, hemp-center, ordinary-lay cable, 1,200 feet in length, is used. Oak idlers measuring 6 inches in diameter by 18 inches in length and having plain bearings, are spaced 12 feet apart along the slope. The life of the cable is usually 12 months. The motor driving the hoist is 15-horsepower, 220-volt, 4.3 ampere, 3 phase, and 60 cycle, and its speed under full load is 830 r.p.m.

The train of 15 cars is cut into three trains of five cars each by a trip rider, who assists the hoist engineer. This man couples the cars to the hoist cable at the bottom and rides outside with them. He then couples a train of five empty cars standing outside near the mine entrance, attaches the hoist cable, and returns again to the slope bottom.

A car will average 4,350 pounds gross and 1,350 pounds net weight. Two and one-half minutes is required by the hoist to pull this train of 5 cars up the slope and over the "hump" outside (fig. 2). As a safety precaution, a 3-foot derailing bar is coupled to the last car.

In addition to operating the electric hoist, the hoistman also tends the roll crusher and the first large conveyor belt. He allows the cars to travel one at a time down a slight grade to a "kick-back" dump 50 inches in length, located directly above the crusher (fig. 8). After dumping, the car is pushed to the empty car siding, where it is coupled to the train by the trip rider.

Outside Storage

In addition to the crushed-clay storage pile described later, a stock pile is provided for weathering the mine-run clay (fig. 9).

This consists of a covered wooden trestle 90 feet in length and 10 feet in height, having removable floor boards between the rails. The mine cars are switched to this trestle, pushed by hand to the desired point, dumped, and returned

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to the empty-car siding. In dumping the cars, a "scotch" is put under the fron wheels and the rear of the car raised by hand. To facilitate this dumping, the center of the car wheel base is placed 3 inches to the rear of the car center (fig. 6). This arrangement permits a storage of approximately 270 tons of clay for weathering.

Pillar Drawing

At the present, three men are engaged in delayed pillar drawing (fig. 4, cross-hatched area). The driller places a round of nine holes in the inby end of the pillar, parallel with the crosscut, and slabs off a 15-foot slice. This cut is carried across the full width of the pillar, and the track is then shifted over and the cycle repeated. Single rows of posts are used to prevent the roof from breaking off at the working face. Posts in the back rows are not recovered. Caving takes place at a safe distance from the working areas in the regular manner.

Miscellaneous

A motor-generator set located in the engine room is used to furnish 250-volt direct current for the mining equipment. The unit is composed of a synchronous 150-horsepower 2,200-volt, 40-ampere, 3-phase, 60-cycle motor, whose speed is 1,200 r.p.m., direct-connected to a generator of 100 Kw.-rating at 2 volts.

The mules are brought to the surface at the end of each shift. As they work in considerable mud and highly acid water they must be washed daily to prevent the spread of infections. To accomplish this task, a novel bath tub has been built. A concrete tank 3 1/2 feet wide, 5 feet deep at the center, and 50 feet long (inside measurements), having a sloping floor at each end, is built flush with the ground not far from the stable. The water is heated to the proper temperature with steam. The mules readily adapt themselves to the bath, and eagerly plunge through it even in the most severe winter weather. the time they swim the length of the tub they are thoroughly cleaned of all r and water. They are then stabled nearby in an excellent circular barn of br construction.

CRUSHING PLANT

The clay from the mine cars is dumped into a 50- by 50- by 40-inch wood hopper, holding one car, or roughly 1 1/2 tons. This hopper is placed direc over a single roll crusher (fig. 10, B). This unit has an 18-inch-diame roll 36 inches in length and is studded with 3- by 3-inch removable teeth. capacity, at 42 r.p.m. or peripheral speed of 198 feet per minute, is 60 ton per hour. It is driven through a 12-inch by 24-foot rubber transmission bel by a 30-horsepower, 75-ampere, 220-volt, 3-phase, 60-cycle motor running at r.p.m. At the normal rate of feed the crusher has sufficient capacity to cr one carload before the next is fed to it, hence runs idle part time. The ma imum size of the product delivered is 6 inches.

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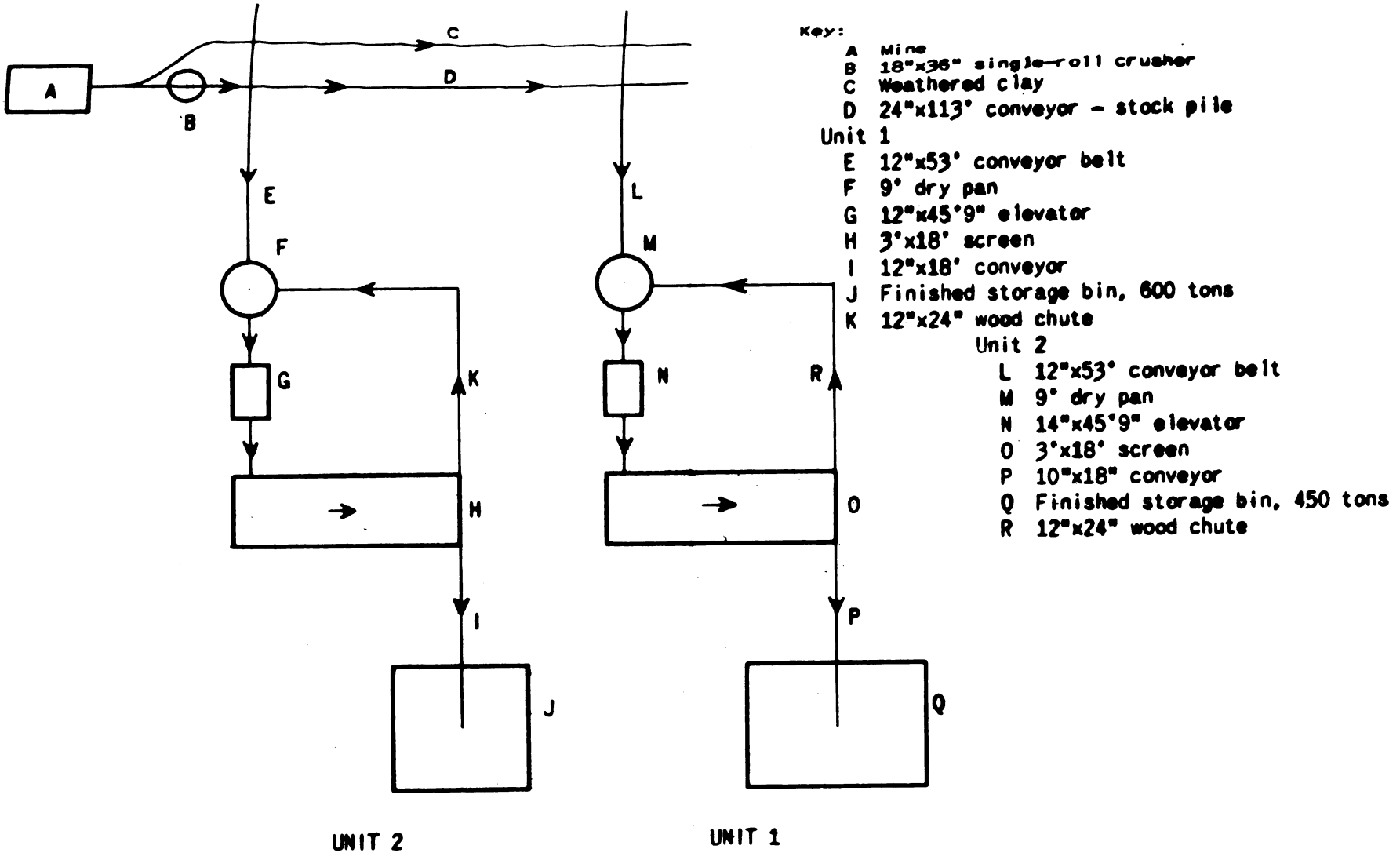

Figure 10.- Flow sheet.

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The clay from the roll crusher falls directly upon a 24-inch rubber conveyor belt and is taken to the stock pile D. The first section of this belt, 63 feet in length, is inclined upward at an angle of 15° from the horizontal, while the remaining 50 feet run horizontally. The belt has sets of five pulley, troughing idlers, 6 inches in diameter and 5 inches face, on the inclined section and five pulley, flat, belt-idlers on the horizontal section, on 48-inch centers. The driving pulley is 28 inches in diameter and has a 26-inch face. Its speed is 48 r.p.m. The capacity of this conveyor at a speed of 350 feet per minute is 250 tons per hour. A 10-horsepower, 220-volt, 28-ampere, 3-phase, 60-cycle motor, rotating at 1,150 r.p.m. drives this unit through a countershaft. The first reduction from the motor is through cut spur-gears, and the final reduction to the headshaft is through 6-inch by 12-foot rubber transmission belt.

A simple board plow is used to discharge the material from the belt. The stock pile proper is under the 50-foot horizontal section of the belt. Its capacity is approximately 440 tons of crushed clay.

Running at right angles to the above belt and located under the floor of the stock pile, are two flat conveyor belts that feed the crushed clay directly into the dry pans. These conveyors are located at either end of the 50-foot horizontal section of the first-described conveyor belt (fig. 9). Hand labor is utilized to recover the clay stored between these two belts and also that from the weathered-clay pile.

By referring to the flow sheet (fig. 10) it will be seen that the clay follows two distinct and separate lines of flow from the stock pile. These will henceforth be designated as unit no. 1 and unit no. 2. The motive power for the former is a 6-inch main-line shaft which in turn is driven by a steam engine located in the nearby engine room and described below. The latter unit has a primary electric motor drive. As the speeds and capacities of the various members of these units, as well as the size of the final product obtained, vary somewhat, each will be considered independently of the other.

Unit No. 1

A 12-inch by 53-foot, flat, horizontal conveyor belt, E, is used to feed the crushed clay from the storage pile directly into the first dry pan, F. Its pulley diameter is 16 inches, face 14 inches, and speed 62 r.p.m. It is driven by a sprocket and chain off the horizontal shaft of the dry pan at a speed of 250 feet per minute. Its capacity at this speed is 48 tons per hour.

The grinding machine is a standard 9-foot dry pan. The forged-steel vertical shaft is 8 inches in diameter at the bottom and 6 inches in diameter at the top and has a heavy forged shoulder for carrying the pan bottom. The pan speed is 32 r.p.m. and its capacity approximately 12 tons per hour. The mullers are 54 inches in diameter and have a 12-inch face. The screen plates are sectional and have 3/16-inch slots. The life of these plates is about 5 months.

The finely ground clay passes through the screen slots and out of the pan bottom into a vertical, wood-enclosed, belt elevator, G, 12 inches by 45 3/4 feet, where it is discharged over a perforated-metal plate screen, H. The

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elevator buckets are 11 by 6 inches, spaced 14 inches apart; pulley diameter is 36 inches, face 16 inches, and speed 48 r.p.m. Its rated capacity at a speed of 450 feet per minute is 225 tons per hour. This unit is driven off the counte shaft on the fourth floor, running at 140 r.p.m., by a 6-inch by 12-foot, rubbe transmission belt.

The perforated screen H is 3 by 18 feet and inclined at an angle of 39° fr the horizontal. The screen proper is made up by placing six perforated metal plates end to end on a wooden frame. Plates with different-diameter perforatio ranging from 3/32 to 1/4 inch are used at the same time. Figure 11a, shows thi plate assembly in detail. The upper end of the screen is pivoted, and the lowe end is supported by a 5/8-inch steel cable running through an overhead pulley t an eccentric located on the countershaft. In this manner, the screen is given vertical motion of 140 impulses per minute. When it approaches the lowest poi in its oscillating movement it strikes a wooden block. The shock of this blow assists the movement of the material through the screen.

Plates of different perforations are used to vary the size gradation of t screened product. Plates all having 3/32-inch perforations are assembled when all fine material is desired. When all coarse material is desired, the larger size perforations are used. Intermediate mixtures are obtained by assembling plates of different perforations. This assembly will give the proper proporti of the clay particles desired for the particular product to be manufactured.

All the material passing through the screen falls upon a flat, horizontal conveyor belt, I, 12 inches by 18 feet, and is discharged into the finished storage bin J. The pulley diameter is 12 inches, face 14 inches, and speed 1 r.p.m. Its capacity at a speed of 330 feet per minute is 65 tons per hour. is driven off the countershaft by a 6-inch, 12-foot, rubber transmission belt

The oversized material falls into a 12- by 24-inch wooden chute, K, and returned to the dry pan.

The finished storage bin J is 32 feet long, 15 feet wide, and 15 feet hi and is capable of holding approximately 600 tons. Three sides of this bin ar constructed of 2- by 10-inch plank on end, while the fourth wall is formed by the outside brick wall of the building itself. Beneath this bin is a plain, wooden, vertical chute having a simple, steel slide gate through which the f ground clay is fed into the wet pan below.

Unit No. 2

This unit also uses a 12-inch by 53-foot horizontal belt conveyor, L, f the stock pile to the dry pan. The pulley diameter is 16-inch, face 14-inch speed 44 r.p.m. It is driven by a sprocket and chain off the horizontal sha of the dry pan at a speed of 184 feet per minute. Its capacity at this spee 45 tons per hour.

Again a standard 9-foot dry pan, M, is used, having the identical size mullers and screen plate openings as those in unit no. 1. The speed of the however, is 34 r.p.m., and its capacity 14 tons per hour.

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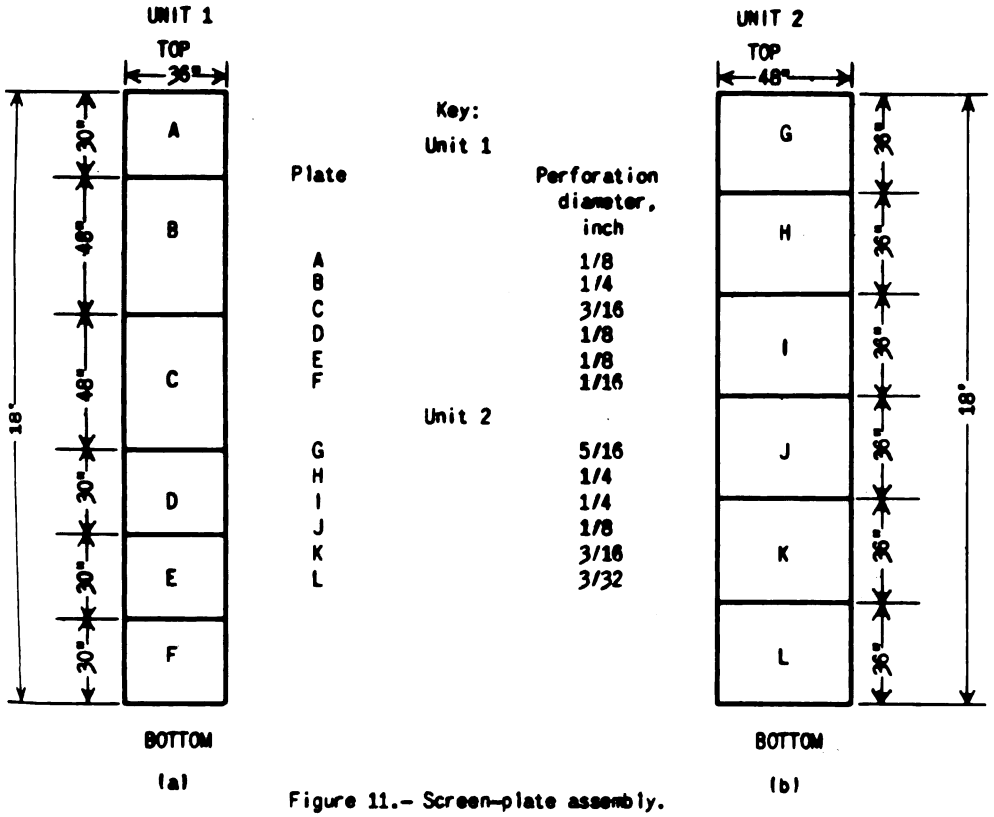

Figure 11.- Screen-plate assembly.

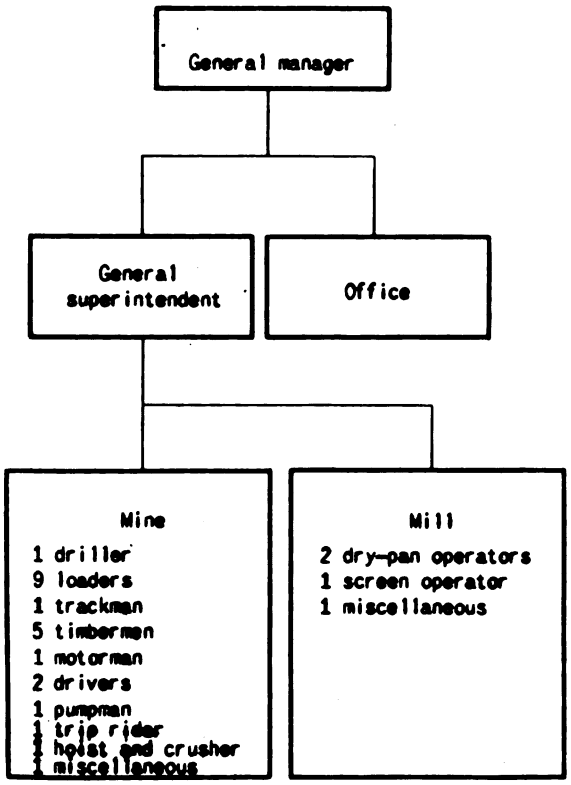

Figure 12.- Organization chart.

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This machine is driven by an 18-inch by 22-foot belt from a countershaft whose speed is 280 r.p.m., which is in turn driven by a 12-inch by 13-foot 6-inch belt by a 50-horsepower, 440-volt, 59-ampere, 3-phase, 60-cycle motor traveling at 1,155 r.p.m.

The ground clay passes from the pan bottom into a vertical, wood-enclosed belt elevator, N, 14 inches by 45 3/4 feet. Buckets 12 by 6 inches are spaced 15 inches apart. The pulley diameter is 36 inches, face 16 inches, and speed 48 r.p.m. The elevator capacity, at a speed of 450 feet per minute, is 260 tons per hour. This elevator is driven by a 6-inch by 12-foot belt off a countershaft traveling at 140 r.p.m., which is in turn driven through a 6-inch by 16-foot, rubber transmission belt by a 10-horsepower, 220-volt, 25.2-ampere, 3-phase, 60 cycle induction motor rotating at 1,160 r.p.m.

The elevator discharges over a perforated metal plate screen, O, 3 feet wide by 18 feet long, which is inclined at an angle of 39° from the horizontal. It is made up of six perforated steel plates, 3 by 4 feet by 3/32 inch, placed end to end on a wooden frame. Here again plates with different-diameter perforations, ranging from 1/16 to 1/4 inch, are used at the same time. Figure 11b, shows the plate assembly of this screen in detail. Vertical motion is imparted to this screen similar to that described in unit no. 1. The material passing over this screen falls into a 12- by 24-inch wooden chute, R, and is returned to the dry pan below.

The material passing through the screen falls upon a flat, horizontal conveyor belt, P, 10 inches by 18 feet, and is discharged into a second finished storage bin, Q. The pulley diameter is 17 inches, face 14 inches, and speed 90 r.p.m. Its capacity, at a speed of 385 feet per minute, is 50 tons per hour. This belt is driven by a 6-inch by 12-foot belt from the electric-motor-driven countershaft.

The finished storage bin in this unit is 24 feet long, 15 feet wide, and 15 feet high, and its capacity is approximately 450 tons. This bin is constructed similar to that described in unit no. 1.

Beneath this bin, two plain, wooden vertical chutes with a slide gate pass the finely ground clay directly into two wet pans for the tempering process.

SCREEN ANALYSIS - WEIGHT PER CUBIC FOOT

Samples taken by the author while the screens were assembled as shown in figure 6 yielded the following results from analyses made in the United States Bureau of Mines laboratory at Pittsburgh, Pa.

Sample obtained from	Screen size	Retained on									
		14	20	28	35	48	65	100	150	200	pass 200
Unit no. 1 screen	Percent	11.5	10.8	10.8	8.8	12.4	8.2	9.0	4.9	5.3	18.3
	cumulative	11.5	22.3	33.1	41.9	54.3	62.5	71.5	76.4	81.7	100.0
Unit no. 2 screen	Percent	29.7	14.1	11.3	6.9	10.4	5.2	6.2	2.9	2.8	10.5
	Cumulative	29.7	43.8	55.1	62.0	72.4	77.6	83.8	86.7	89.5	100.0

WEIGHT PER CUBIC FOOT

Sample from	Specific Gravity	Weight, lb. per cu. foot
Unit no. 1 screen	2.672	167.0
Unit no. 2 screen	2.683	167.7

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MISCELLANEOUS PLANT

Four 150-horsepower, horizontal return tube boilers are in constant use. They supply steam for the 350-horsepower engine described below and for the t pipe presses. When the plant is operating, exhaust steam from the engine is used in the drying rooms, otherwise live steam is used.

Motive power for the main-line shaft in the plant is supplied by a 350-horsepower, 18- by 42-inch simple steam engine, equipped with Corliss valves. The line shaft is coupled direct to the flywheel shaft and rotates at 88 r.p. This shaft in turn drives all the equipment described in unit no. 1 above and in addition, three wet pans, two elevators, and several small conveyors.

PERCENT EXTRACTION

The first mining operation yields approximately a 20 percent recovery o clay. Should all the pillars be removed, this would ordinarily mean a 100 p cent recovery. However, due to sloughing, roof falls, contamination, squeez and other causes, about 10 percent is lost. This leaves an estimated 90 per extraction in the present workings.

In the older workings where the pillars were not drawn, the timbering i such poor condition that it is problematical whether the pillar clay will ev be recovered. The chances are it will be lost entirely, as the cost of drai retimbering, and relaying rails in this territory would be prohibitive.

EMPLOYEE PAY SYSTEM

The hourly rate of pay is in use for all labor except the loaders. The rates for an 8-hour working day are as follows:

Classification	No. of men	Hourly rate
Drillers	1	$0.62
Trackmen	1	.62
Timbermen	5	.62
Motorman	1	.62
Drivers	2	.62
Pumpmen	1	.59
Trip rider	1	.59
Hoist and crusher operator	1	.59
Miscellaneous mine	1	.59
Dry-pan operators	2	.47
Screen operator	1	.47
Miscellaneous mill	1	.47

SAFETY METHODS AND FIRST-AID ORGANIZATION AND TRAINING

Safety is continually stressed throughout the mine and mill. For cuts minor injuries, first-aid materials are available. Army stretchers are pro for major accidents which necessitate transporting the patient by automobi Uhrichsville.

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At present no first-aid organization is functioning, and no training classes are being conducted.

FORM OF ADMINISTRATIVE ORGANIZATION

The general superintendent has full jurisdiction over both mine and mill, being directly responsible to the general manager. A mine and mill foreman are accountable to the general superintendent for the operation of their respective units.

Figure 12 is an organization chart showing the distribution of authority.

ELECTRIC POWER

Electric current at 2,200 volts is purchased on a sliding-scale basis from the Ohio Power Co. The rate averages 3 1/2 cents per Kilowatt-hour.

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I - SUMMARY OF COSTS

NAME: Evans Pipe Co., Uhrichsville, Ohio PERIOD COVERED: 1935

TOTAL TONS CLAY LOADED: 21,680

OPERATING COSTS PER DRY TON OF CLAY MINED

Classification	Labor	Super-vision	Air Drills Steel	Power Cost	Fuel Cost	Explo-sives	Other Supp.	Tot
Drilling and blasting	$0.0377	.....	$0.0037	.....	....	$0.0753	$0.0007	$0.
Loading	.3539	.....	.....	.....	....	.....	.0014	.
Transportation	.1516	.....	.....	$0.0316	....	.....	.0479	.
Timbering	.2059	.....	.....	.....	....	.....	.0564	.
Pumping	.0349	.....	.....	.1634	....	.....	.0060	.
Hoisting	.0542	.....	.....	.0041	....	.....	.0023	.
Miscellaneous	.0211	$0.0675	.....	.....	....	.....	.0030	.
Crushing	.0172	.....	.....	.0272	....	.....	.0018	.
Grinding	.0537	.....	.....	.0541	$0.0824	.....	.0028	.
Screening	.0137	.....	.....	.....	....	.....	.0013	.
Elevating	.0069	.....	.....	.0101	.0165	.....	.0012	.
Conveying	.0070	.....	.....	.0114	.0033	.....	.0013	
Storage - in	.0261	.....	.....	.....	....	.....	.0004	
Miscellaneous	.....	.0050	.....	.....	....	.....	.....	
Total	.9839	.0725	.0037	.3019	.1022	.0753	.1265	1

Note: - The fuel costs of the various steam-driven units were estimated.

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II - SUMMARY OF COSTS IN UNITS OF LABOR, POWER, AND SUPPLIES

NAME: Evans Pipe Co., Uhrichsville, Ohio PERIOD COVERED: 1935

TOTAL TONS CLAY LOADED: 21,680

	Mining	Crushing	Other	Total
A. Labor (man-hr. per ton)				
Drilling and blasting	0.0552	.....	.....	0.0552
Loading	.4970	.....	.....	.4970
Haulage	.1936	.....	.....	.1936
Timbering	.2765	.....	.....	.2765
Pumping	.0552	.....	.....	.0552
Hoisting	.0830	.....	.....	.0830
Miscellaneous	.0552	0.0276	0.2214	.3042
TOTAL LABOR	1.2157	.0276	.2214	1.4647
Ave. tons per man per shift	8.83	190.00	47.50	7.30
Labor, percent of total cost				63.63
B. Power supplies				
Explosives (lb.per ton)	0.4500	.....	.....	0.4500
Timber (lin.ft.per ton)	.7180	.....	.....	.7180
Total power	.....	.....	.....	.....
1. Drilling Kw.-hr.	.0412	.....	.....	.0412
2. Locomotives do.	.9020	.....	.....	.9020
3. Pumping do.	4.6700	.....	.....	4.6700
4. Hoisting do.	.1151	.....	.....	.1151
5. Ventilation do.	.2060	.....	.....	.2060
6. Crushing do.	.....	0.7760	.....	0.7760
7. Grinding do.	.....	1.5480	.....	1.5480
Do. hp.-hr.	.....	2.7620	.....	2.7620
8. Screening	.....	.....	.....	.....
9. Elevating Kw.-hr.	.....	.2890	.....	.2890
Do. hp.-hr.	.....	.5530	.....	.5530
10. Conveying Kw.-hr.	.....	.3180	.....	.3180
Do. hp.-hr.	.....	.1106	.....	.1106
Other supplies, percent of total supplies	.....	.....	.....	20.71
Supplies and power, percent of total cost	.....	.....	.....	36.37

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III - DETAILED SUMMARY COSTS - DIRECT OPERATION MINE

NAME: Evans Pipe Co., Uhrichsville, Ohio PERIOD COVERED: 1935

Classification	Amount	Cost per ton	Total c per to
Loading	$7,715.00	$0.3553	$0.3553
Drilling			
Operating Labor	372.00	.0171	
Air, gas, power	81.00	.0037	
Operating Supplies	15.00	.0007	
Repair Labor	75.00	.0035	
Repair Supplies	.....	.....	
Total drilling	543.00	.0250	.025
Blasting			
Labor	372.00	.0171	
Explosives	1,637.78	.0753	
Other supplies	.....	.....	
Total blasting	2,009.78	.0924	.092
Haulage			
Locomotive	1,979.13	.0911	
Mules	1,988.00	.0916	
Cars	286.00	.0132	
Track maintenance	764.00	.0352	
Total haulage	5,017.13	.2311	.23
Timbering			
Labor	4,464.00	.2059	
Supplies	1,225.00	.0564	
Total timbering	5,689.00	.2623	.26
General charges	7,738.94	.3565	.35
Grand total	28,712.85	1.3226	1.3

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